Chapter 12

Safety Requirements

12.1 Validity

This Chapter refers to personnel-related safety with the DASY5 system and summarizes such aspects.

12.2 Configuration

This Chapter is valid for the following system configurations, including parts **A** and **B** as listed below:

Item / Configuration:

A Dosimetric Assessment System DASY5: SD 000 510 A (DASY5 SAR) / SD 000 520 A (DASY5 PRO) / SD 000 530 A (DASY5 NEO)

B with Safety curtain add-on

Type / Version No:

A1 with Stäubli robot arm TX60L and controller type CS8c

A2 with Stäubli robot arm TX90XL and controller type CS8c

A3 with Stäubli robot arm TX160L and controller type CS8c

B1 QE UMS 001 B (Safety Curtain Kit)

B2 QE UMS 002 B (Perimeter Safety Curtain Kit)

B3 Enclosure with safety contact (with equivalent safety function)

For sufficient personnel safety, all instructions in this Chapter, in the DASY5 manual (Chapter 11 System Description and Setup, Chapter 3 Robot, Chapter 13 Connection and Use of Safeguarding Equipment) as well as in the References Section at the end of this Chapter must carefully be followed and fully complied with.

In the above configuration, and considering applicable documentation, the system meets the European safety standards according to [4].

DANGER: The safety devices and the interconnection to the machinery must comply with the basic safety requirements as mentioned in the applicable national regulations and standards.

WARNING: When changing / adding / removing any item in the configuration, the system must not be operated before compliance with local laws and standards has been verified.

12.3 Documentation and Training

The manuals (DASY5, Stäubli and CEDES manual) are part of the system. They must be kept accessible during the whole life cycle for everyone who is in charge of installation, operation, maintenance and safety control.

Training by qualified personnel is required before operating the system. This is necessary not only for personnel safety, but also for preventing damage to the test equipment, and to achieve the required accuracy with the system.

DANGER: This system includes a computer-controlled robot positioner. Should the manuals not be carefully followed, serious injury or death may occur. Only personnel trained with the system and familiar with all applicable safety aspects may operate the system. The responsible operator has to ensure that no injuries or damage can occur and that the safety regulations are observed.

12.4 Robot Safety

General

No obstacles or persons must be within the movement range of the measurement probe positioner (robot arm). Safeguarding equipment must be installed and connected to prevent personnel entering the danger area during automatic operation. Item **B** shall be installed to be compliant with the European Machinery directive or similar safety regulations.

DANGER: Access to the system within the safety distances given below is not allowed during automatic mode. In manual modes, special precautions are necessary.

WARNING: Manual operation of the robot arm is possible using the operating elements at the base of the arm. In this case, precautions according to the robot manual [1] are to be obeyed, because the arm sections may fall down when the selected brake is released.

The safety prescriptions according to the DASY manual (Chapter 11 System Description and Setup, Chapter 3 Robot, Chapter 13 Connection and Use of Safeguarding Equipment), according to the robot manual [1] and according to the safety light curtain [3] have to be followed strictly.

Safety distances

The safety distances are dependent on the robot type and the type of the safeguarding equipment installed. Using equipment **B1** or **B2** described in [3], the safety distances calculated according to [2] apply.

Safety distances between the safeguarding equipment and the most dangerous part of the robot (DAE) are calculated for the following combinations:

A1 + B1 570 mm

A2 + B1 1090 mm

A3 + B1 1320 mm

A1 + B2 1250 mm

A2 + B2 1770 mm

A3 + B2 2000 mm

The respective curtain must switch off the system if it is interrupted. The installation must follow the conditions given in [3].

Further distances are applicable for the installation of the equipment: Distance from the wall according to Chapter 11 System Description and Setup.

DANGER: Compared to previous versions of the DASY system, with the DASY5 system, robot movements can be faster, sometimes unpredictable for the observer. In SAR and HAC measurements, the robot hand may move outside the phantom outline. Access to the robot arm within the safety distances is therefore strictly forbidden during automatic operation.

Signal lamps

The signal lamps must be well visible to allow clear indication of the system safety status. The signal lamps are controlled by the PC software. They are not active if the robot is operated in a special configuration without the measurement server. The colors have the following meanings:

- Red: Danger, automatic operation, no presence within the safety distances allowed.
- Blue: Caution, manual operation, presence in the vicinity of the robot only using the teach pendant with the dead-man-switch activated.
- Green: Safe, no remote operation possible. Robot arm brakes are activated.

Note: The green LED indicators on the front of the robot controller and the measurement server do NOT indicate that the system is safe.

Emergency switches

Emergency switches are located at the front panel of the robot controller, on the manual teach pendant of the robot and on the DASY5 remote control unit. During operation, at least one of the switches must be within reach. They shall only be used for switching off the robot arm power in emergency situations.

Shortcut Plugs

Shortcut plugs on the measurement server (Safety / Control: Door Contacts) or on the robot controller (see robot manual) will override certain safety functions.

DANGER: The shortcut plug on the the Measurement Server (Door Contacts) overrides external safeguarding equipment. Operation of the system is only allowed in manual mode. In automatic mode, access to the robot arm must not be possible.

Note: The configuration known to the DASY5 operating software must coincide with reality. The coordinates of system elements such as the phantom, light-beam or free height definition must be adapted to the real situation. Re-teaching is required as soon as one component has been moved, or if the configuration is unsure. Also, user-defined phantoms and points must be set carefully in order not to cause damage. Therefore, such definition operations are restricted to the administrator access level in the software.

Manual control

Manual control is possible and required in some cases (like moving between phantoms and teaching coordinates). In this mode, the blue signal lamp will be lit.

WARNING: The dead man switch must be active (pressed manually) during this type of operation. The operator must be able to take immediate action by releasing this switch in dangerous or frightening conditions. The operator is also able to switch to manual mode using the teach pendant. The warnings on its display must be obeyed in this case. The operator must leave the robot arm working range and move outside of the safety distance before switching back to automatic mode.

12.5 Electrical Safety

Mains voltagesof 50V are available for the following parts:

- Robot subsystem (robot controller, robot arm and interconnecting cable)
- DASY5 Measurement Server
- PC

Their cabinets must only be opened by trained personnel and after the mains is interrupted. Follow the respective manuals when doing so.

The robot controller has a mains wiring directly attached to terminals behind the front cover. Before removing this cover or working at the terminals, make sure that no voltage is available. The opposite side of the cable must be disconnected by a switch or connected before any manipulation at the terminals.

Fuses may only be replaced by units with the proper rating.

Wiring and cabling shall not be exposed to chemical agents like the simulating liquids.

Special Grounding may be required to reduce system noise during the measurements. Such grounding shall be in addition to the safety grounding available for personnel protection. Ground wires used for personnel protection must not be disconnected or removed.

12.6 Electromagnetic Compatibility

Radiating sources (Devices Under Test, test generators) will be operated with the system, but are not part of it. The system is therefore assumed to be operated within a shielded facility with a filtered mains input **C1**. The operator of the system is responsible for the compliance of any signal emitted from Devices Under Test or other equipment (e.g., CW test signals) with local regulations and laws.

The system is designed to be operated with emitters to be used for operation close to the human body and to evaluate the Specific Absorption Rate of mobile phones according to IEC 62209 and similar standards. The system may also be used to measure considerably higher field strengths than allowed according to the local laws and regulations (e.g., using the free-field probes).

WARNING: Operators and other personnel must be sufficiently protected from electromagnetic radiation from devices under test before compliance with the local exposure limits is proven. Special caution and protection is required in cases of unknown fields.

Only the probes shall be exposed to the high radiated fields. The DAE is connected with an optical link to the system electronics. Other system components (e.g., Robot controller, Measurement Server, PC, etc.) and their interconnection wiring shall not be exposed to field strengths exceeding 10 V/m.

12.7 Optical Safety

Optical links in the visible range are used for serial communication with the DAE. The optical cables and connectors shall not be looked at from short distances. Please refer to Chapter 2.

The light beam contains an IEC LASER Class 2 according to IEC 60825 at the visible wavelength of 670nm with a power of less than 0.2 mW. It can be hazardous if there is direct intentional long-term ocular exposure (0,25 seconds). This laser is active during the installation of the lightbeam as well as the alignment of the probe. Do not look directly into the beam. Neither look directly to the beam when deflecte from an object like the probe. The operator is responsble for the safety of the personnel during its operation.

Please refer to Chapter 2.5.1 for further details.

12.8 Chemical Safety

Simulating Liquids

Tissue Simulating Liquids used with the system may be harmful and irritant. The Manufacturer Safety Data Sheets (MSDS) of the relevant components must be observed during manufacturing, handling, using, storage and disposal of the ingredients. The responsible operator has to take precautions that any personnel will not be harmed by the liquids, even when the system is not operated (e.g., outside working times). Harmful liquids shall be emptied from the system and stored correctly in their storage containers.

WARNING: Disposal of DGMBE and oil based liquids is not allowed in the environent or water drains. Also for liquids with other ingredients, consult the respective MSDS and follow applicable local regulations and laws.

Note: Not all system components (phantom shells, probes, etc.) are compatible with all types of liquids and chemicals. In addition, some of the components are not compatible for long-time use. Check for the compatibility of the materials before use.

Cleaning agents

Do not use solvents for cleaning unless explicitly prescribed or allowed.

Batteries

Batteries are included in the robot controller (buffering the position calibration memory) and for operation of the DAE electronics. Additional batteries may be present in the PC and in test instruments.

Observe the requirements for the maintenance of the batteries.

WARNING: Charge batteries only with the proper charger and if allowed. Batteries may explode if not charged properly, if short-circuited or if disposed of in fire.

Dispose of batteries properly according to local laws. Whenever possible, rechargeable batteries shall be used.

12.9 Maintenance and Inspection

Safety installations and protective devices must always work properly and therefore need periodic inspection and test. Such tests and inspections shall be carried out during their life cycle according to the current laws and regulations by qualified and trained persons. If safety relevant damages, defects or modifications have occurred, operation of the system must not be continued until the safety situation fulfills the requirements.

Maintenance is to be performed according to the manuals of the subsystems.

Ventilation openings shall be cleaned regularly. Front panel, signal lamps and safeguarding equipment shall be tested at least once a month.

Phantom Shells shall be exposed to liquids only as long as required for the operation. Operation and cleaning processes shall not damage the coating in order to keep the sealing function of the surfaces. Check the sealing function of drainage taps every time when filling the phantom shell.

Note: Do not use aggressive solvents or abrasive substances for cleaning. Do not use sharp-edged tools to stir liquids

12.10 Disposal

Safety installations must only be removed if the system will be taken out of operation permanently. This has to be done by removing the mains supply from the system. The state of the disposed system must be such that it cannot be put into operation without using tools.

If the system needs to be disposed of, it can easily be disassembled and recycled using state of the art recycling technology and following current disposal regulation. Special considerations are required for the robot arm (gear oil included), batteries and simulating liquids as mentioned above.

Other system parts (i.e., PCBs, cables) may be disposed of as standard electronic material.

12.11 Uninterruptible Power Supply

Uninterruptible Power Supplies (UPS) are widely used to protect sensitive equipment against interruptions of the power net. In addition, UPS ensure that the power supply for the protected equipment is stable by monitoring and filtering the mains.

The functional principle is that the UPS is connected between the mains and the protected equipment. During normal operation the input AC voltage is rectified and the resulting DC voltage is used to charge the internal batteries of the UPS. Furthermore, the DC voltage is converted to a proper AC output voltage using an inverter to supply the load. In case of an interruption of the power net or in case of instable voltage from the mains the internal batteries take over to supply the load via the inverter. The autonomy time, what means the time the protected equipment can be operated powered by the batteries inside the UPS, is depending on the size of the battery as well as on the power consumption of the connected equipment. Short interruptions can be handled by the UPS. For longer interruption of the power net, the UPS provides enough time to properly switch off the connected equipment and thus to avoid damage and the loss of data.

With DASY5 there are two major concerns regarding an interruption of the power supply: the robot and the controlling PC. Regarding the PC a loss of measurement results might occur which would result in a repetition of the measurement running before. Related to the robot, an interruption of the power supply could cause an uncontrolled movement of the robot arm. The consequence is a potential risk or damage for the DASY5 equipment and personnel.

In case of an interruption to the three-phase power supply the power to the amplifiers and with this to the motors is removed immediately. But for the brakes it takes some hundred milliseconds to close. With this it can happen that the robot arm falls down up to several centimeters without control what could cause damages to the probe or to the DAE. Furthermore the scan which was in progress is interrupted and in case that also the power supply of the controlling PC was affected by the interruption it is likely that the collected data is lost. With this the scan would have to be repeated. Also in case the power supply is not interrupted but the power net is not stable,

problems similar to the ones described for the power interruptions might occur. In these cases it is advisable to use a UPS.

12.12 References

[1] Robot Manuals (TX60L, TX90XL, RX160L, CS8c), Stäubli SA, Faverges, France

[2] Guide for Safety equipment, CEDES, October 2002

[3] CEDES, 102261E Technical Description for Safe4 Safety Light Curtain

[4] DASY5 Declaration of conformity, January 2007